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SEASAT EQUATOR CROSSING PROGRAM.(U)
JUN 80 B G YOUNG, D L DESAULNIERS
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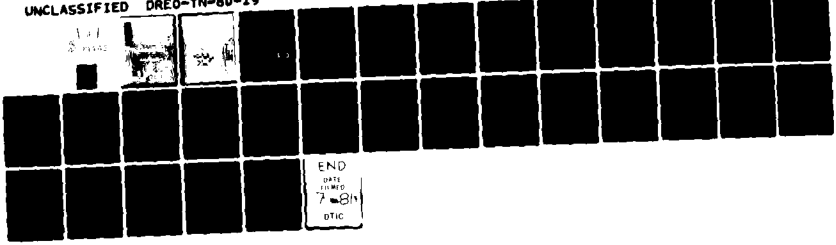

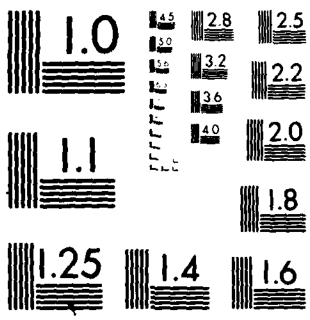

MICROCOPY RESOLUTION TEST CHART
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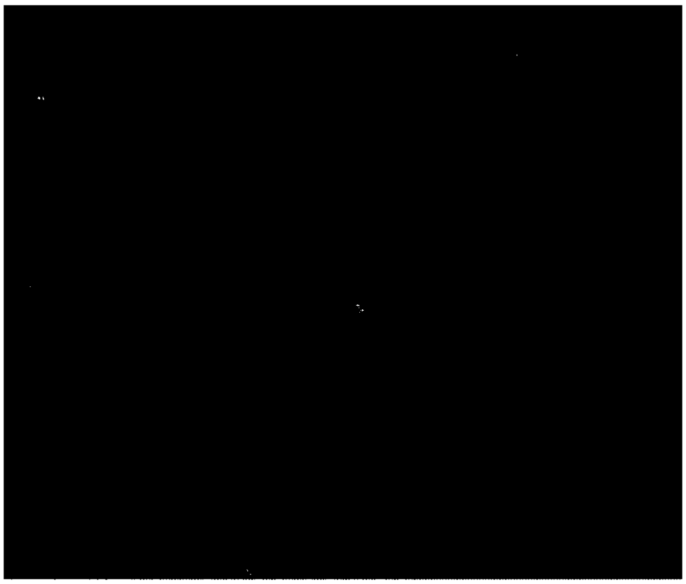

RESEARCH AND DEVELOPMENT BRANCH

DEPARTMENT OF NATIONAL DEFENCE
CANADA

DEFENCE RESEARCH ESTABLISHMENT OTTAWA

TECHNICAL NOTE NO. 80-10

SEASAT EQUATOR CROSSING PROGRAM

by

B.G. Young and D.L. [illegible]
Defence Electronics Division

PROJECT NO.
[illegible]

JUNE 1980
OTTAWA

ABSTRACT

A programmable pocket calculator is used to extrapolate the SEASAT orbit from the equator crossing to the position at which the synthetic aperture radar images a given target. The program predicts the coordinates of the satellite at image time, the Azimuth direction of the image at the target, and the time elapsed between equator crossing and imaging. Program predictions are compared with measured SEASAT data from the definitive attitude-orbit files.

RÉSUMÉ

Ce rapport décrit le logiciel d'une calculatrice de poche programmable pour l'extrapolation de l'orbite du satellite SEASAT à partir de sa traversée au-dessus de l'équateur jusqu'à sa position lorsque le radar à antenne synthétique image une cible. Ce programme permet de prévoir les coordonnées du satellite au moment de la production de l'image, la direction azimuthale de l'image au point de la cible et le temps écoulé entre le passage à l'équateur et celui de la production de l'image. Ces prédictions sont comparées avec les données mesurées de SEASAT contenues dans les fichiers à bandes magnétiques des données définitives d'attitudes et d'orbites.

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1.0 [illegible]

[illegible] is a program for the HP-67 hand calculator to predict when a given target will be imaged by the [illegible] synthetic aperture radar (SAR) and from what direction. [illegible]

[illegible]

[illegible]

[illegible]

2.0 [illegible]

[illegible]

[illegible]

earth rotation and orbit precession during the time the satellite travels from node to image point. Here nadir is the intersection of the satellite position vector with the earth's surface. The node is the point in east longitude at which the satellite crosses the equator. The [illegible] parameters shown in Table 1 for the SEASAT orbit were published by [illegible] before launch in July [illegible].

Table 1

[illegible]

[illegible]

[illegible]

[illegible]

i) [illegible]
ii) [illegible]
iii) [illegible]

[illegible]

[illegible]

$$[illegible] \qquad (1)$$

$$[illegible] \qquad (2)$$

$$[illegible] \qquad (3)$$

The equator crossing point [illegible] for an orbit [illegible] are calculated in three steps. First, the intersection of the [illegible] orbit plane through [illegible] with the equator are found from the right spherical triangle ABC in Figure 1 [illegible]. Here C = 90°, [illegible] (inclination [illegible]) [illegible] and

$$[illegible] \qquad (4)$$

$$[illegible] \qquad (5)$$

$$[illegible] \qquad (6)$$

[illegible]

$$[illegible] \qquad (7)$$

[illegible]

$$[illegible] \qquad (8)$$

[illegible]

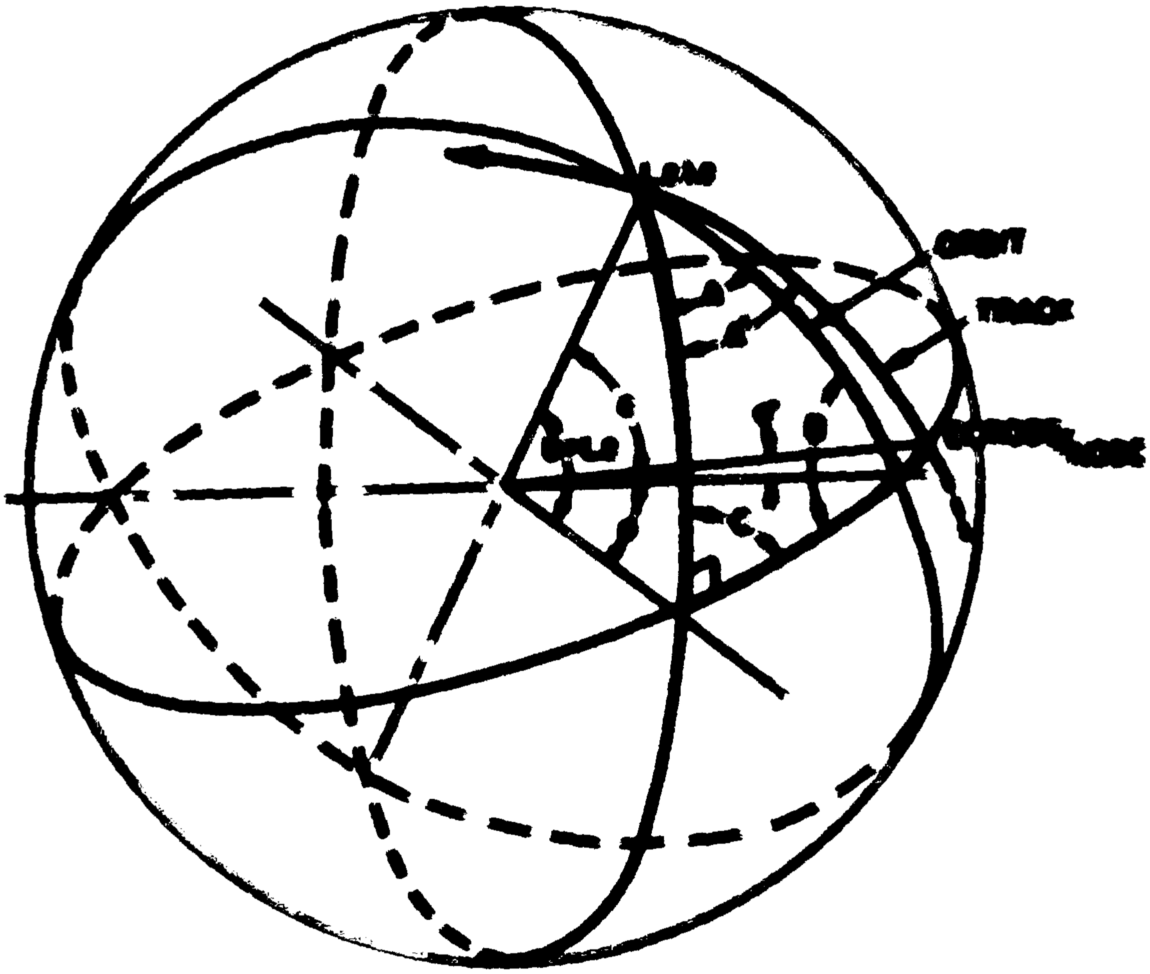
[illegible]

$$[illegible] \qquad (9)$$

$$[illegible] \qquad (10)$$

[illegible]

[illegible]


ORBIT
TRACK

Finally, new values of θ were calculated by relations (14) and (15).

$$\theta_\varphi = \cos^{-1}\left[\frac{\sin L_1 - \cos(D/60)\sin L_2}{\sin(D/60)\cos L_2}\right] . \qquad (11)$$

[illegible] (12)

[illegible] (13)

[illegible] (14)

[illegible] (15)

[illegible] ascending and descending [illegible] of Figure [illegible].

[illegible]

[illegible] (16)

where

[illegible]

[illegible] (17)

[illegible] (18)

[illegible] (19)

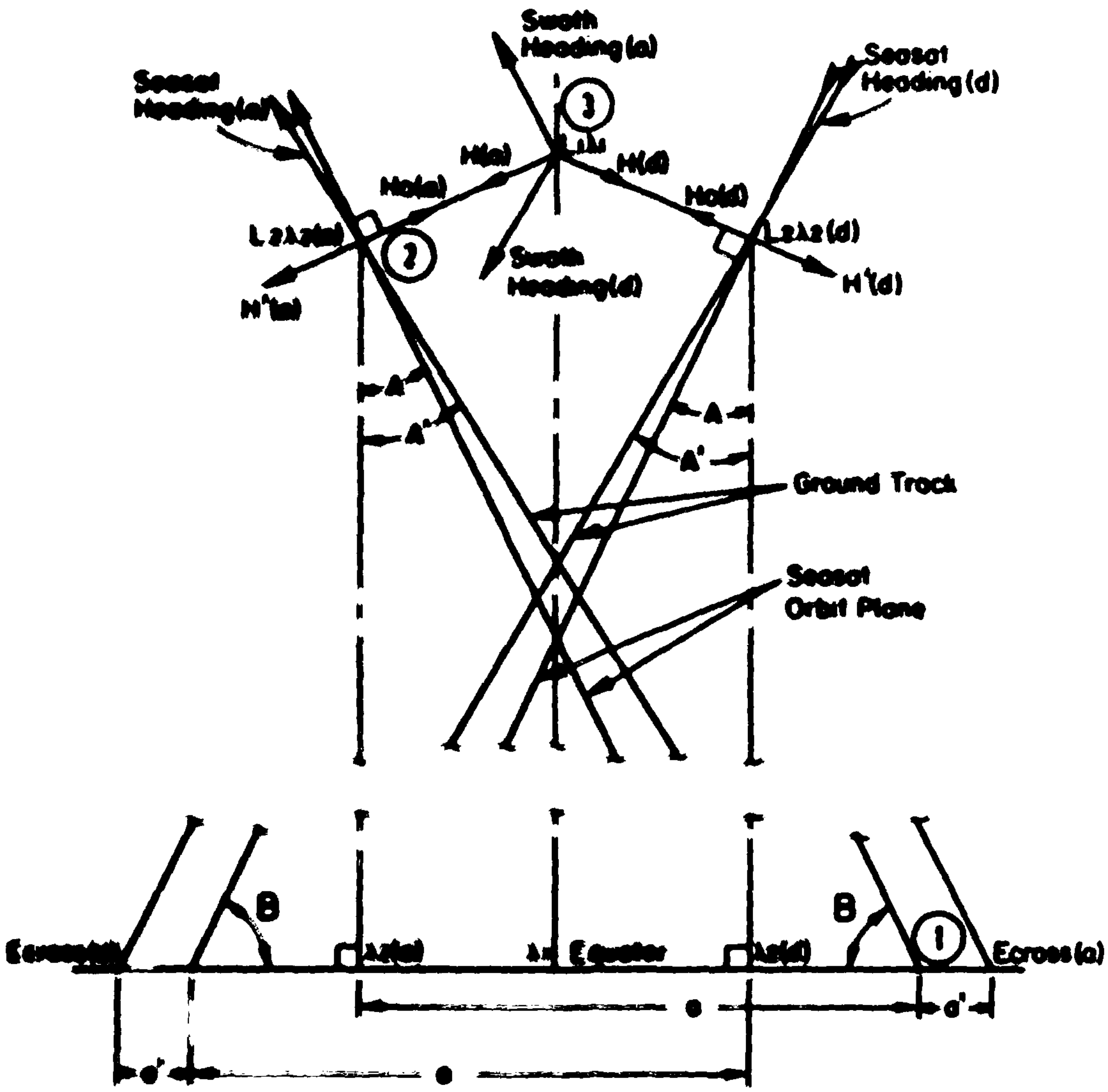
[illegible]

[illegible]

[illegible]

[illegible] (20)

[illegible]



Swath Heading (a)
Seasat Heading (d)
Seasat Heading (a)
H(a)
H(d)
Ho(a)
Ho(d)
Swath Heading (d)
H'(d)
A
A'
Ground Track
Seasat Orbit Plane
B
Equator
Ecross (a)
e
d'

TABLE II

User Instructions

SEASAT Equator Crossing a (ascending) d (descending) 3/80

L_1 | λ_1 | E_{cross} | T_{lapse} | Heading

STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS		OUTPUT DATA/UNITS
1	Enter program, both sides				
2	Enter latitude of target *	L_1	A		6.0 (I)
3	Change I?	I	h	STI	
4	Change D/60? (nm/min)	D/60	STO	6	
5	Change inclination? (dec. deg)	90-B	STO	7	
6	Change T/360? (min/deg)	T/360	STO	8	
7	Enter longitude of target * (W)	λ_1	B		
8	Calculate SEASAT equator crossing (E. Long)		C		E_{cross}
9	Calculate time in minutes between equator crossing and target imaging		D		T_{lapse}
10	Calculate heading of SAR swath at target		E		Swath Heading
	* Enter lat. and long. in the form DDD.MMSS eg. 130.5732 means 130 degrees, 57 minutes, 32 seconds				

TABLE III

PROGRAM LISTING, ASCENDING (a)

STEP	KEY ENTRY	KEY CODE	COMMENTS	STEP	KEY ENTRY	KEY CODE	COMMENTS
001	LBL A	31 25 11			LBL B	31 25 12	
	DSP 4	23 04			H +	31 74	
	H +	31 74			STO 2	33 02	λ_1
	STO 1	33 01	L_1	060	RTN	35 22	
	2	02			LBL E	31 25 15	
	.	83			P/S	31 42	
	7	07			RCL 6	34 06	
	7	07			P/S	31 42	
	1	01			RTN	35 22	
010	7	07			LBL D	31 25 14	
	7	07			P/S	31 42	
	8	08			RCL 1	34 01	
	2	02			P/S	31 42	
	5	05		070	RTN	35 22	
	8	08			LBL C	31 25 13	
	STO 6	33 06	D/60		RCL 1	34 01	
	1	01			COS	31 63	
	8	08			RCL 6	34 06	
	.	83			SIN	31 62	
020	0	00			x	71	
	0	00			RCL 5	34 05	
	0	00			COS	31 63	
	0	00			x	71	
	0	00		080	RCL 6	34 06	
	0	00			COS	31 63	
	0	00			RCL 1	34 01	
	STO 7	33 07	90-B		SIN	31 62	
	.	83			x	71	
	2	02			+	61	
030	4	04			SIN^{-1}	32 62	
	9	09			STO 3	33 03	L_2
	2	02			SIN	31 62	
	6	06			RCL 1	34 01	
	3	03		090	SIN	31 62	
	6	06			x	71	
	8	08			RCL 6	34 06	
	9	09			COS	31 63	
	STO 9	33 09	$(W - \Omega)/(24 \times 60)$		−	51	
	.	83			CHS	42	
040	2	02			RCL 1	34 01	
	7	07			COS	31 63	
	9	09			RCL 3	34 03	
	8	08			COS	31 63	
	6	06		100	x	71	
	1	01			÷	81	
	1	01			COS^{-1}	32 63	
	1	01			RCL 2	34 02	
	1	01			+	61	
	STO 8	33 08	T/360		STO 4	33 04	λ_2
050	1	01			3	03	
	8	08			6	06	
	5	05			0	00	
	STO 5	33 05	H initial		−	51	
	6	06		110	CHS	42	
	STI	35 33			P/S	31 42	
	RTN	35 22			STO 8	33 08	

REGISTERS

0	1	2	3	4	5	6	7	8	9
a	L_1	λ_1	L_2	λ_2	H	D/60	90-B	T/360	$\frac{W - \Omega}{24 \times 60}$
S0	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**
H^1	T_{lapse}	$a + a^1$	H_o	SEASAT Heading	ΔH	Swath Heading		E_{cross}	

A	B	C	D	E	I
L_1	λ_1	E_{cross}	T_{lapse}	Swath Heading	6

TABLE III (cont'd)

STEP	KEY ENTRY	KEY CODE	COMMENTS	STEP	KEY ENTRY	KEY CODE	COMMENTS
	P/S	31 42			STO 3	33 03	H_o
	RCL 7	34 07		170	P/S	31 42	
	SIN	31 62			1	01	
	RCL 3	34 03			8	08	
	COS	31 63			0	00	
	÷	81			+	61	
	SIN^{-1}	32 62	A		RCL 5	34 05	
120	2	02			-	51	
	7	07			CHS	42	
	0	00			P/S	31 42	
	-	51			STO 5	33 05	
	CHS	42		180	RCL 0	34 00	
	P/S	31 42			P/S	31 42	
	STO 0	33 00	H^1		+	61	
	P/S	31 42			STO 5	33 05	H
	SIN	31 62			RCL 3	34 03	
	CHS	42			COS	31 63	
130	RCL 7	34 07			RCL 8	34 08	
	COS	31 63			X	71	
	÷	81			RCL 9	34 09	
	COS^{-1}	32 63			X	71	
	STO 0	33 00	a	190	P/S	31 42	
	COS	31 63			RCL 0	34 00	
	RCL 3	34 03			COS	31 63	
	COS	31 63			-	51	
	X	71			CHS	42	
	COS^{-1}	32 63	c		RCL 0	34 00	
140	RCL 8	34 08			SIN	31 62	
	X	71			÷	81	
	P/S	31 42			TAN^{-1}	32 64	A^1
	STO 1	33 01	T_{lapse}		3	03	
	P/S	31 42		200	6	06	
	RCL 9	34 09			0	00	
	X	71			-	51	
	RCL 0	34 00			CHS	42	
	+	61			STO 4	33 04	SEASAT Heading
	P/S	31 42			RCL 5	34 05	
150	STO 2	33 02	$a + a^1$		+	61	
	STO + 8	33 61 08	E_{cross}		STO 6	33 06	Swath Heading
	P/S	31 42			P/S	31 42	
	RCL 1	34 01			DSZ	31 33	
	SIN	31 62		210	GTO C	22 13	
	RCL 6	34 06			P/S	31 42	
	COS	31 63			RCL 8	34 08	E_{cross}
	RCL 3	34 03			P/S	31 42	
	SIN	31 62			RTN	35 22	
	X	71					
160	-	51					
	RCL 6	34 06					
	SIN	31 62					
	RCL 3	34 03					
	COS	31 63		220			
	X	71					
	÷	81					
	COS^{-1}	32 63					
	P/S	31 42					

LABELS					FLAGS	SET STATUS		
A L_1	B λ_1	C E_{cross}	D T_{lapse}	E Swath Heading	0	FLAGS	TRIG	DISP
a	b	c	d	e	1	ON OFF	DEG	FIX
0	1	2	3	4	2	0	GRAD	SCI
5	6	7	8	9	3	1	RAD	ENG
						2		n ____
						3		

TABLE IV

PROGRAM LISTING, DESCENDING (d)

STEP	KEY ENTRY	KEY CODE	COMMENTS	STEP	KEY ENTRY	KEY CODE	COMMENTS
001	LBL A	31 25 11			LBL B	31 25 12	
	DSP 4	23 04			H ←	31 74	
	H ←	31 74			STO 2	33 02	λ_1
	STO 1	33 01	L_1	060	RTN	35 22	
	2	02			LBL E	31 25 15	
	.	83			P/S	31 42	
	7	07			RCL 0	34 00	
	7	07			P/S	31 42	
	1	01			RTN	35 22	
010	7	07			LBL D	31 25 14	
	7	07			P/S	31 42	
	8	08			RCL 1	34 01	
	2	02			P/S	31 42	
	5	05		070	RTN	35 22	
	8	08			LBL C	31 25 13	
	STO 6	33 06	D/60		RCL 1	34 01	
	1	01			COS	31 63	
	8	08			RCL 0	34 00	
	.	83			SIN	31 62	
020	0	00			x	71	
	0	00			RCL 5	34 05	
	0	00			COS	31 63	
	0	00			x	71	
	0	00		080	RCL 4	34 04	
	0	00			COS	31 63	
	0	00			RCL 1	34 01	
	STO 7	33 07	90-B		SIN	31 62	
	.	83			x	71	
	2	02			+	61	
030	4	04			SIN^{-1}	32 62	
	9	09			STO 3	33 03	L_2
	2	02			SIN	31 62	
	4	04			RCL 1	34 01	
	3	03		090	SIN	31 62	
	6	06			x	71	
	8	08			RCL 6	34 06	
	9	09			COS	31 63	
	STO 9	33 09	(W - Ω)/(24 x 60)		-	51	
	.	83			CHS	42	
040	2	02			RCL 1	34 01	
	7	07			COS	31 63	
	9	09			RCL 3	34 03	
	8	08			COS	31 63	
	6	06		100	x	71	
	1	01			÷	81	
	1	01			COS^{-1}	32 63	
	1	01			RCL 2	34 02	
	1	01			-	51	
	STO 8	33 08	T/360		CHS	42	
050	1	01			STO 4	33 04	λ_2
	7	07			3	03	
	5	05			6	06	
	STO 5	33 05	H initial		0	00	
	6	06		110	-	51	
	STI	35 33			CHS	42	
	RTN	35 22			P/S	31 42	

REGISTERS

0	1	2	3	4	5	6	7	8	9
a	L_1	λ_1	L_2	λ_2	H	D/60	90 - B	T/360	$\frac{W - \Omega}{24 \times 60}$
S0	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**
H^1	T_{lapse}	$a + a^1$	$360 - H_o$	Seasat Heading	ΔH	Swath Heading		E_{cross}	

A	B	C	D	E	I
L_1	λ_1	E_{cross}	T_{lapse}	Swath Heading	

[illegible]

STEP	KEY ENTRY	KEY CODE	COMMENTS
	STO 5	33 05	
	R/S	31 42	
	RCL 7	34 07	
	SIN	31 62	
	RCL 3	34 03	
	COS	31 63	
	×	71	
	SIN⁻¹	32 62	
	6	06	
	0	00	
	÷	81	
	R/S	31 42	
	STO 0	33 00	[illegible]
	R/S	31 42	
	SIN	31 62	
	RCL 4	34 04	
	COS	31 63	
		[illegible]	
	COS⁻¹	32 63	
	STO 6	33 06	[illegible]
	COS	31 63	
	RCL 3	34 03	
	COS	31 63	
	×	71	
	COS	[illegible]	[illegible]
	RCL 6	34 06	
	×	71	
	R/S	31 42	
	STO 1	33 01	[illegible]
	R/S	31 42	
	RCL 0	34 00	
	+	61	[illegible]
	RCL 0	34 00	
	+	61	
	R/S	31 42	
	STO 2	33 02	[illegible]
	STO - 0	33 51 00	[illegible]
	R/S	31 42	
	RCL 1	34 01	
	SIN	31 62	
	RCL 6	34 06	
	COS	31 63	
	RCL 2	34 02	
	SIN	31 62	
	×	71	
	-	51	
	RCL 6	34 06	
	SIN	31 62	
	RCL 1	34 01	
	COS	31 63	
	×	71	
	÷	81	
	COS	[illegible]	
	R/S	31 42	
	STO 3	33 03	θ_0 (360 - ϕ_0)
	R/S	31 42	

STEP	KEY ENTRY	KEY CODE	COMMENTS
	RCL 7	34 07	
	[illegible]	[illegible]	
	[illegible]	[illegible]	
	[illegible]	[illegible]	
	[illegible]	[illegible]	
		[illegible]	
	[illegible]	[illegible]	
	[illegible]	[illegible]	[illegible]
	RCL [illegible]	[illegible]	
	[illegible]	[illegible]	
	[illegible]	[illegible]	
	[illegible]	[illegible]	[illegible]
	RCL [illegible]	[illegible]	
	[illegible]	[illegible]	
	RCL [illegible]	[illegible]	
	[illegible]	[illegible]	
	RCL [illegible]	[illegible]	
	[illegible]	[illegible]	
	[illegible]	[illegible]	
	RCL [illegible]	[illegible]	
	[illegible]	[illegible]	
	[illegible]	[illegible]	
	[illegible]	[illegible]	
	RCL [illegible]	[illegible]	
	[illegible]	[illegible]	
	[illegible]	[illegible]	
	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	
	[illegible]	[illegible]	
	[illegible]	[illegible]	
	[illegible]	[illegible]	
	[illegible]	[illegible]	[illegible] Heading
	[illegible]	[illegible]	
	[illegible]	[illegible]	
	[illegible]	[illegible]	South Heading
	[illegible]	[illegible]	
	[illegible]	31 33	
	[illegible]	22 13	
	R/S	31 42	
	RCL 2	34 02	[illegible]
	R/S	31 42	
	[illegible]	35 22	

LABELS					FLAGS	SET STATUS		
[illegible]	[illegible]	[illegible]	[illegible]	South Heading		FLAGS	TRIG	DISP
						ON OFF	DEG GRAD RAD	FIX SCI ENG n

[illegible]

[illegible]

5.0 [illegible]

[illegible]

5.1 Problem 1 Revolution Number to Image a Target

Given the table of [illegible] and the coordinates of the Citadel at Halifax, N.S., find the revolution numbers of the satellite orbits in the month of August 1979 during which SAR imagery of the target in the ascending mode can be collected.

The geographic coordinates of the Citadel are 44° 39' N, 63° 35' W and the corresponding geocentric latitude L_c, given by equation (20), is 44° 27' 24" N. Using these coordinates with the [illegible] values for near and far range edges of the SAR swath, we find that the [illegible] ranges from 313.2779°

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

1. [illegible]
2. [illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

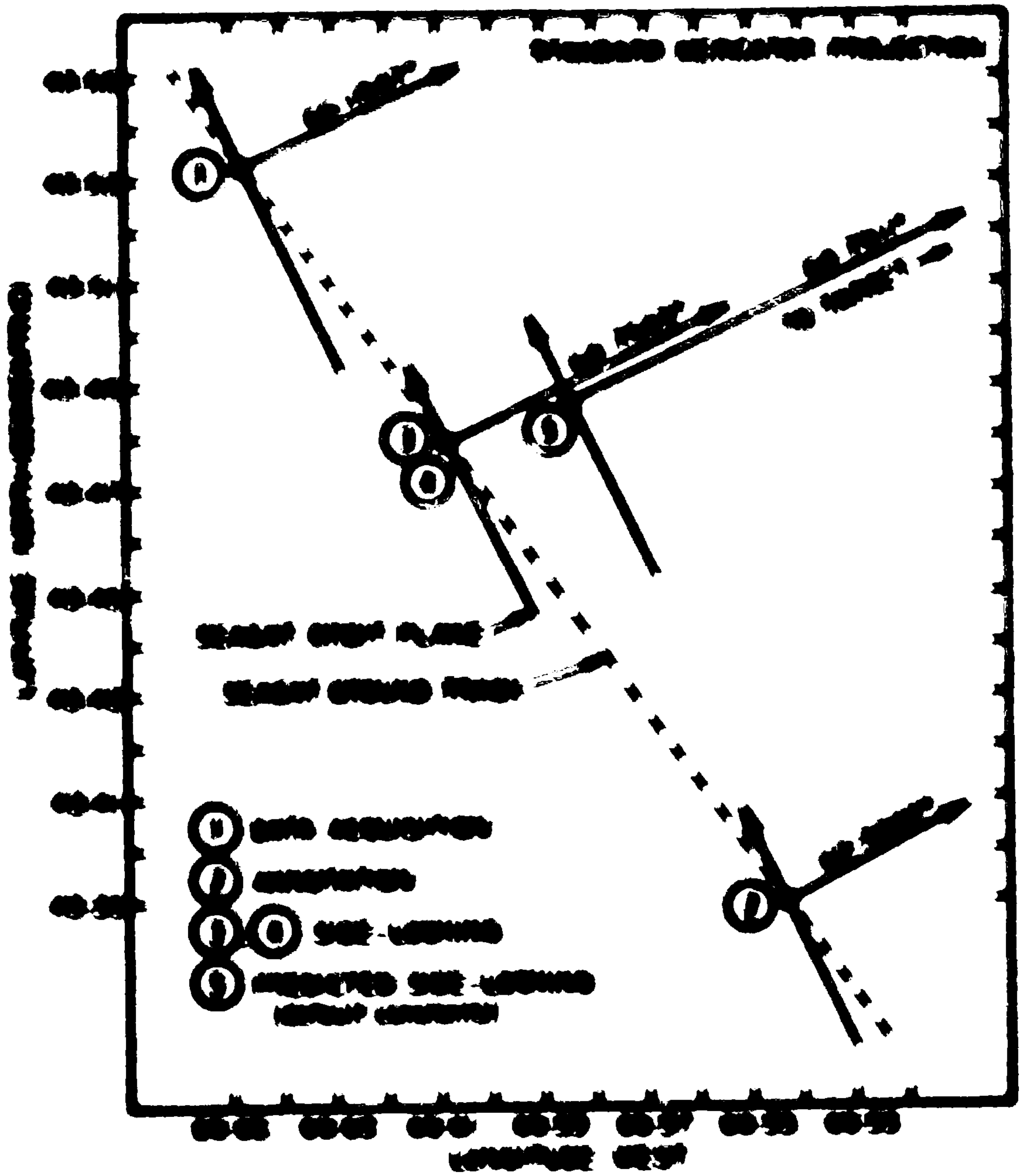
[illegible]

[illegible]
[illegible]
[illegible]

[illegible]

[illegible]

[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]



[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

$$[illegible] \quad (2?)$$

[illegible]

[illegible]

[illegible]

TABLE VIII

SEASAT SAR IMAGING PARAMETERS

Parameter	3 A/O Tape (side-looking time)	4 HP-67 (constants from 3)
Latitude θ_s N	44.4566	44.4566
Longitude λ_s W	63.5833	63.5833
$R_{ascension}$/Node E	314.5999	314.5999
Node Time (GMT)	13:33:30.55	13:33:30.55
Latitude θ_t N	43.4784	43.4784
Longitude λ_t W	66.6077	66.6077
"Image" Time (GMT)	13:46:28.42	13:46:28.42
t_{lapse} (min)	12.9645	12.9645
Clock Angle	90.0000	90.0000
North Heading	334.2897	334.2897
SEASAT Heading	332.1897	332.1897
Distance to Target (Km)	265.1617	265.1617
Heading to Target	64.7543	64.7543
Orbit/Equator Intersect W	48.6317	48. 6317
Orbit Inclination	108.0281	108.0281
Orbit Period (min)	100.6889	100.6889

TABLE IX

SEASAT SAR IMAGING PARAMETERS

Parameter	3 A/O Tape (side-looking time)	5 HP-67 (default constants)	Diff.
Latitude L_1 N	44.4566	44.4566	-
Longitude λ_1 W	63.5833	63.5833	-
E_{cross}/Node E	314.5999	314.5999	-
Node Time (GMT)	13:33:30.55	13:33:30.55	-
Latitude L_2 N	43.4784	43.4873	+0.0089
Longitude λ_2 W	66.6077	66.5844	-0.0233
'Image' Time (GMT)	13:46:28.42	13:46:28.90	+0.48 sec
T_{lapse} (min)	12.9645	12.9725	+0.0080 min
Clock Angle	90.0000	90.0000	-
South Heading	334.2897	334.3085	+0.0188
SEASAT Heading	332.1897	332.2245	+0.0348
Distance to Target (Km)	265.1617	263.0470	-2.1147
Heading to Target	64.7543	64.7911	+0.0368
Orbit/Equator Intersect W	48.6317	48.6337	+0.0020
Orbit Inclination	108.0281	108.0000	-0.0281
Orbit Period (min)	100.6889	100.7500	+0.0611

change in image time is 1.9833 seconds.

The effect of satellite attitude on annotation time can be shown by expressing the pitch and yaw angles (-0.3587° and 0.3818° respectively at data acquisition time) as a squint angle in the slant range plane. Pitch and yaw normally deviate from the design specifications by less than 0.5°. Small angle approximation is therefore acceptable. Let the SEASAT SAR beam shift ϕs radians from the side-looking position in the slant range plane. The velocity component in the slant range direction due to ϕs is $v_s = \phi sV$ and the corresponding shift of the image in the cross range direction is, from equation (21) $\Delta X = \phi sR$. The change in time is $\Delta T = \phi sR/V$. Note that the image shift ΔX is equal in magnitude but opposite in direction to the extra distance the satellite travels beyond the side-looking position to acquire the radar data in the squint mode. In other words, the annotation time on the image will always be the side-looking time, to the small angle approximation, independent of the radar squint angle if corrections for earth rotation and precession have been applied.

The image shift ΔX from a squint angle of 0.008030 radians at the data acquisition position is 6.8099 km. The annotation time due to misalignment alone would be 1.0284 seconds earlier. These values are in good agreement with the great circle distance between the satellite nadir positions in data sets 1 and 3 of 6.8120 km, and the time difference of 1.0053 seconds between the data acquisition time and the side-looking time.

The annotation time in the Halifax frame from Rev. No. 1238 correlated by MDA (MacDonald Dettwiler and Associates) is about 2.66 seconds earlier than the acquisition time [4]. Interpolation from the Halifax frame yields an annotation time for the Halifax Citadel of 13:46:26.78 and the data acquisition time, 2.66 seconds later, of 13:46:29.44 GMT. This value of the data acquisition time is in good agreement with that in data set 1, 13:36:29.43, calculated from the A/O tape. However the annotation time is 0.33 seconds later than would be expected from the sum of the time diplacements from radar squint and earth rotation, 2.99 seconds. The reason for this difference is not known but is assumed to result from the approximations used in calculating the slant range velocity. The MDA annotation time was used to extract data set 2 in Table VII from the A/O tape and the coordinates for point 2 in Figure 3.

5.5 *Discussion*

The SEASAT ground track shown by the dotted line in Figure 3 represents the attitude - orbit tape data to within 0.002°, the error ascribed to the linear interpolation between orbit entries. Satellite positions along the ground track are less accurate and the data acquisition and side-looking positions, 1 and 3 respectively, depend on the unknown accuracy of the precession correction.

The attitude of the satellite is apparently not predictable and no attempt was made to incorporate an equivalent yaw correction into the calculator

program.

Nominal beamwidth of the SEASAT SAR was 1.25° and the equivalent yaw at image time was about 1.4648°. Therefore, it is clear that the target could not have been illuminated from the side-looking or annotation positions at 2 and 3.

6.0 CONCLUSIONS

1. A program for the HP-67 programmable pocket calculator to extrapolate the SEASAT ground track up to one quarter of a revolution beyond the node has been developed and tested. It was shown that SEASAT orbit parameters which were measured during the satellite's lifetime can be fitted by the program using three constants.

2. Using the prelaunch design parameters as the default constants, the calculator program predicts SEASAT SAR imaging parameters which fall well within the limits imposed by the normal, but unpredictable, attitude variations. These limits introduce an uncertainty of a few seconds in the data acquisition time and up to a tenth of a degree uncertaintly in the satellite position coordinates. When accurate data acquisition times are required, the program can provide information to help aim a radar detector at the passing satellite.

7.0 REFERENCES

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13 ABSTRACT

A programmable pocket calculator is used to extrapolate the SEASAT orbit from the equator crossing to the position at which the synthetic aperture radar images a given target. The program predicts the coordinates of the satellite at image time, the Azimuth direction of the image at the target, and the time elapsed between equator crossing and imaging. Program predictions are compared with measured SEASAT data from the definitive attitude-orbit files.

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HP-67 PROGRAM

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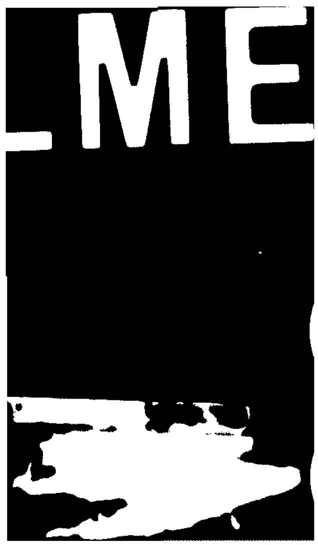
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